Considerations for Condition Assessment & Rating

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This presentation

- Problem: Condition Assessment for CW
- Background (Why are Dave/Stuart Here?)
- Notions of condition assessment
  - lessons learned / take aways
  - recent survey
- Links to relevant reports
- Questions

Problem: Condition Assessment

- Asset Management for Civil Works
  - huge inventory across multiple business/mission lines
  - life-cycle notions of
    - condition, functionality
    - performance = F(condition, functionality)
    - risk, reliability
    - economy
  - procedures: inspection & assessment (ratings)
  - prioritize budget work packages
  - through compliance, multiple standards, policy
    - rationale for program requirements
    - rational program execution

Background

- 1980's CERL
  - Personal Computers!
  - Surge in data based applications
    - GRASS - early GIS
    - EMS – early Asset Management
- Engineered Mgmt Systems
  - Condition Indexes (CI's)
  - Track condition trends, condition prediction
  - Consequence models (deferred maintenance)
  - PAVER, ROOFER, RAILER, BUILDER, Others

REMR R&D Program, 1984-1998

- Operations Management
  - CI = Distress Inspection & Condition Rating
  - REMR CI's for CW infrastructure
    - steel sheet pile
    - gates & valves (sector, miter, tainter, roller, butterfly)
    - gate operating equipment
    - concrete monoliths (locks, retaining walls, spillways)
    - breakwaters & jetties (rubble, non-rubble hybrid)
    - riverine dike, revetment
    - embankment dams
    - hydropower (HDC developed – not CERL)

O&M Tools R&D Prog, 2000-2001

- Carry Over from REMR
  - Simplify REMR CI's
  - Characterize USACE O&M work package prioritization schema
  - only partially completed (lost funding)

Lessons / Take Aways

- “Condition, Risk, _X_” is hard to quantify
- Even the most objective measurements are based on human subjectivity
  - e.g. USACE inventory is so diverse; getting consensus on “allowable displacements” is difficult
  - e.g. low lift gates, high lift gates, elastic anchorage systems
  - establishment of condition inspection & rating procedures is iterative process

Lessons / Take Aways

- CI's are largely misunderstood
  - they are only part of the overall picture
  - There are lots of CI's out there and they're all over the map
- Be very clear on what a CI is and isn't
- Condition and Function are not always the same thing
  - e.g. riverine dikes & revetment, coastal B&J's

What About the REMR CI's?

- Designed to be -
  - "objective", as points on a curve
  - repeatable measurements
  - meaningful descriptions of "condition"
- But they –
  - can't be used alone for prioritization
  - require training
  - are labor intensive
  - aren't supported corporately

Quantified Knowledge

Applies to condition rating, prioritization methods, SPRA[1], coastal . . . , whatever!

- If Subjectivity = TODAY
- and If Objectivity = UTOPIA
- What is our best expectation?
  - Consistency! Consistency! Consistency!
  - and this <u>is</u> achievable

[1]Screening for Portfolio Risk Assessment

M&R Planning Criteria

- Asset Management for Civil Works
  - huge inventory across multiple business/mission lines
  - life-cycle notions of
    - condition, functionality
    - performance = F(condition, functionality)
    - risk, reliability
    - economy
  - procedures: inspection & assessment (ratings)
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M&R Planning Criteria

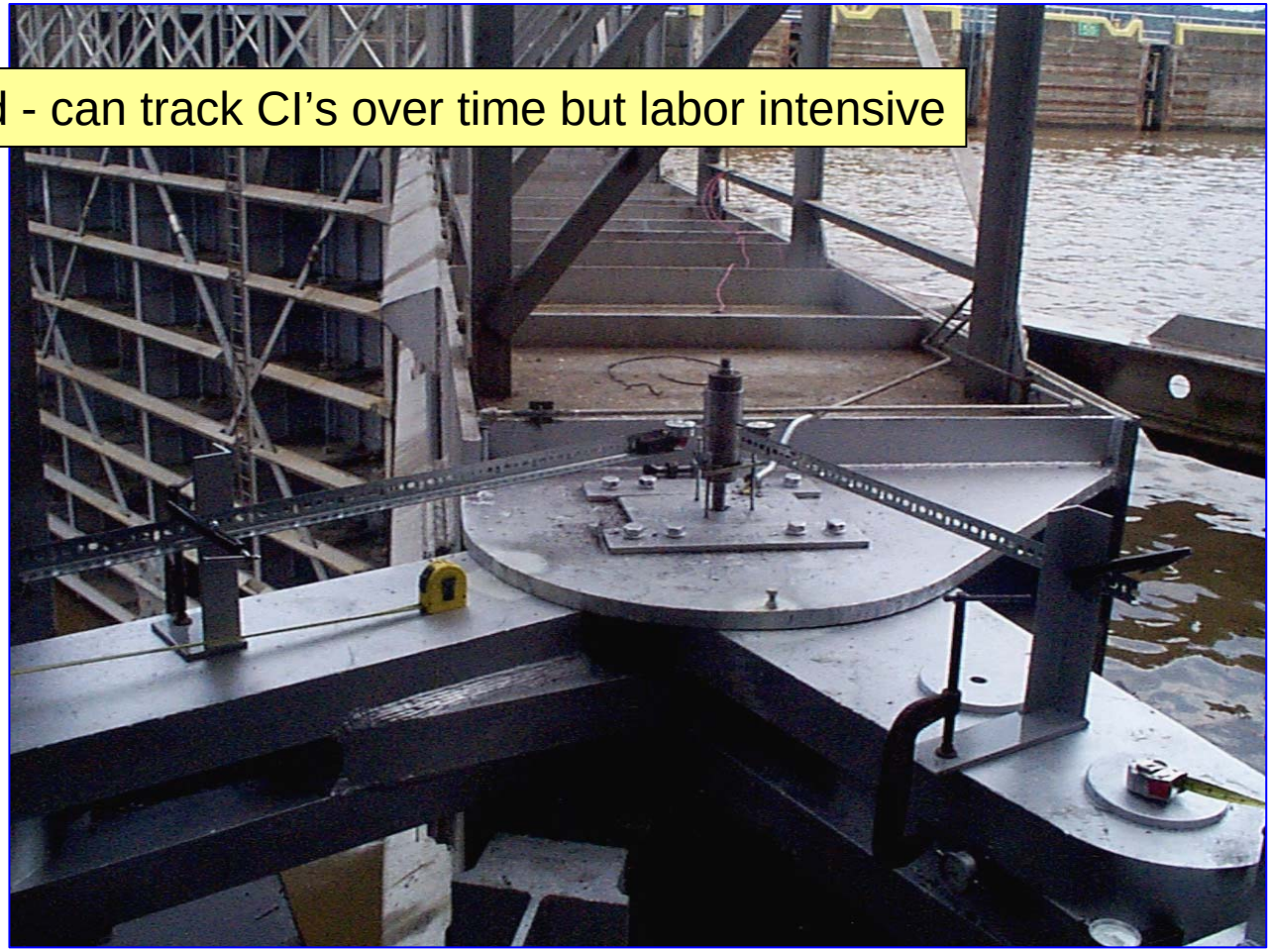
- Condition (wear, corrosion, breakage, etc.)
- Function (efficiency, aesthetics, ease or use, speed, etc.)
- Performance
  - Condition and Function
- Risk (workers, customers, neighbors, etc.)
  - Probability and Consequences
- Economics
  - USACE, local, national, current, future
- Policies and Priorities
  - economics, environment, health and safety, harbors of refuge, future environment, risk

Inspection and Rating Methods

- How do they differ?
  - degrees of subjectivity
    - what is measured and how?
    - consistency and repeatability
  - level of effort, cost
  - level of accuracy
    - amount of detail
- Results should be independent of expertise of inspectors????

Detailed and Accurate

very detailed - can track CI's over time but labor intensive



Detailed and Less Accurate

Lifting device structure (steel)									
Function	Provide structural support for the hoisting device (and carrying tracks for mobile hoisting device)								
Excellent	Comprehensive structural inspection has been performed. All critical structural members fully accessible for inspection. No visible cracks, no visible member deformation, no corrosion, no missing bolts or members, no visible misalignment.								
Failed	Visible deformations, missing parts, or cracks of a load-carrying member. Corrosion resulting in the loss of more than 20% of the cross-section of critical structural member. Missing bolts or cracked welds on a facture critical member or connection (a non-redundant tensile member or connection whose loss would result in the collapse of the structure).								
Indicator	0 -- 9	10 -- 24	25 -- 39	40 -- 54	55 -- 69	70 -- 84	85 -- 100	Score	Comments
Displacement and deterioration									
No misalignment in a dedicated hoisting mechanism							X	100	
Displacement and deterioration of the structure causing visible or measurable misalignment in a hoisting mechanism with no effect on lifting						X			
Displacement and deterioration of the structure causing visible or measurable misalignment in a hoisting mechanism with excessive noise and vibration				X	X				
Displacement and deterioration of the structure causing visible or measurable misalignment in a hoisting mechanism with motor overload		X	X						
Displacement and deterioration of the structure causing visible or measurable misalignment in a hoisting mechanism that cannot be lifted	X								
Anchor bolts									
No corrosion							X		
Corrosion on nuts and bolts				X	X	X		80	some rust
Cracks in the concrete around the bolt and or missing concrete around the bolt		X	X						

e.g. part of Spillway Distress Table

can be performed with experts in a room but result fuzzier

Least Detail and Accuracy

Rating	Rating Criteria
C1 - Excellent	No major deficiencies. None or few minor new deficiencies. All old deficiencies noted in the last inspection have been corrected.
C2 - Very Good	No major deficiencies. Several new minor deficiencies. Most old deficiencies noted in the last inspection have been corrected.
C3 - Good	Few or no new major deficiencies. Numerous new minor deficiencies and/or several old minor deficiencies noted in the last inspection have not been corrected. Annual maintenance performed, but additional effort is needed.
C4 - Fair	Major deficiencies that if not corrected immediately may lead to or cause deterioration of the project such that is incapable of providing the ce of minimum maintenance performed. A greater effort is required to reduce deficiencies.
C-5 Poor	Major deficiencies such the structural integrity or the flood control project will probably not withstand a major flood event. Little or no evidence of maintenance performed.

least useful/robust and cheapest but serves some purposes

Need-Based Inspections

- Scheduling
  - By the calendar
  - When needed (after incident or poor behavior noted)
- Inspection type
  - checklist, scorecard
  - Distress based
  - Deficiency based

Condition Rating Objectives

- Guide inspection
- Quantify condition
- Consistent inspection process
- Discover problems
- Identify and gauge distresses (severity, density)
- Uniform inspection results
- Create condition history
  - Tracking change (web db – centralized, statistics)
  - Risk & Reliability (probability of failure) USACE is very poor at keeping failure data because there's too much to track

CA Survey FY08

- Condition Assessment (CA) Methods
  - telephone interviews (30 responses)
  - Corps wide, most types of infrastructure covered, dam safety, navigation, Ops personnel
- Basic conclusions:
  - Districts following established guidelines for CA but largely "doing their own thing" in judging severity
  - Dependence on team experience and familiarity
  - CA: does not mean the same thing to all people
  - CA related decisions work well at tactical levels but is not enough for AM decisions at strategic (Division, HQ) level
- More, report due late summer 08
  - Specific CA/AM recommendations

Is AM Problem Solvable?

- 1984 REMR: Remove subjectivity from the budget work package prioritization process with focus on condition assessment.

- 2008 NAV: Remove subjectivity from the budget work package prioritization with focus on condition assessment, risk/reliability, environment, local economic impact, . . . etc.

Essayons!

Links to Reports

REMR Reports

http://owww.cecer.army.mil/fl/remr/remr.html

Understanding Condition Indexes

http://owww.cecer.army.mil/techreports/Foltz_CI_Benefits/Foltz_CI_Benefits.pdf

Non Rubble Breakwater

http://www.wes.army.mil/REMR/pdf/om/ERDC-CERL-TR-REMR-OM-26.pdf

Rubble Breakwater

http://owww.cecer.army.mil/techreports/plorub/plorubb.remr.post.pdf

Condition Assessment Aspects of an Asset Management Program

http://www.cecer.army.mil/techreports/ERDC-CERL_SR-08-1/ERDC-CERL_SR-08-1.pdf

Ethics Analogy

- How do we define what is good and bad?
  - Utility
    - Greatest benefit
    - Least harm
  - Religious doctrine*
  - Morality
  - Conformity to nature*
  - Personal interest
  - Common good
  - Desirable*
  - Pleasurable*

*Bertrand Russell - 1910